

A MANUAL FOR TREE NURSERY MANAGEMENT

(A Practical Guide on Tree Nursery Practices)

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A Kenya Forestry Research Institute (KEFRI)/Forest Department (FD)
German Development Co-operation (GTZ) Publication under the auspices of the
Promotion of Sustainable Forest Management Project



PREFACE

This nursery manual was written to guide the development and management of both public and private tree nurseries. The manual provides practical guidelines for nursery workers, extensionists and farmers. We are confident that it will be a useful reference material for those who have no past practical knowledge of raising tree seedlings.

The idea of writing this manual was conceived by researchers in the Promotion of Sustainable Forest Management Project (PSFM) at the Kenya Forestry Research Institute (KEFRI) in response to an omission pointed out during the mid-term review of the Kenya Forestry Development Programme of the Forest Department (FD). It was realised that while there exists a technical order on nursery, this was at best available to the trained foresters. However the nursery supervisor had no reference while he/she is the person carrying out the actual work. The manual contains information obtained from experience over a number of years that allowed close interaction between the researchers and extension agents. Vigorous field participation in discussions have greatly assisted in making this manual as practical as any field person could require. The authors have been in charge of research nurseries in a number of stations and are currently running one at Muguga. Wide hands on experience have contributed greatly in making this manual a handy reference for all nursery workers. Among the topics covered are the nursery establishment, tending and handling of seedlings, as well as stressing the importance of maintaining the nursery records.

FEB 2000



ACKNOWLEDGEMENTS

The following individuals who read the manuscript and gave valuable comments are acknowledged.

B. Kigomo, E.M. Chagala, G.M. Kinyanjui, J.M. Wanyiri, T.K. Njagi, P. Mung'ala, R. Schulzke, J. Githiomi, M.W. Muniu, T. Omenda, F.L. Namusende, C.M. Muchoki and C.K. Kiriinya.

Members of the KEFRI/FD Technical Liaison Committee who gave ideas on the layout and generally commented on the contents of the manual are greatly acknowledged.

C. Nyogot drew the illustrations. Schulzke provided the front cover photograph.

GTZ provided assistance to publish the manual.

M.N. Muchiri, Project Manager, PSFM Project, KEFRI for proof reading the draft.

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TABLE OF CONTENTS

INTRODUCTION	1
SITING TREE NURSERY	2
SEED SOWING BED	4
NURSERY SOIL	6
Seedling Bed	6
Polyethylene Tubes	7
POTTING	8
PRICKING OUT SEEDLINGS	8
SHADING	11
TENDING OF SEEDLINGS	12
Watering	12
Weeding	13
Root pruning	13
NURSERY RECORD KEEPING	15
Nursery Diary Book	15
DISEASE AND INSECT PESTS ATTACK	15
TRANSPLANTING SEEDLINGS IN THE FIELD	15
GLOSSARY	17
FURTHER READINGS	19

INTRODUCTION

This manual is written as a guide for the development and management of tree nurseries mainly in the high potential areas of the country. The main goal of good nursery management is to facilitate the production of healthy vigorous planting stock. While the manual is meant to be more useful in the high potential areas, it would also be valuable in the dry land areas. It will be a useful reference material for extension foresters, schools, women groups and farmers interested in raising tree seedlings.

People have taken to raising their own tree seedlings for planting as well as for sale. Presently, the nursery practice among farmers and other interested individuals borrow heavily on what is applied on agricultural crops as forestry related information is not readily available. Where this information is available, it is not in a form that is easily understood since such is meant for people with some forestry training background. These guidelines will therefore assist such groups of people in establishing their own tree nurseries for their domestic use and commercial purposes.

Currently forest workers in nurseries carry out the various activities without or with very limited knowledge as to why such activities are carried out. This publication will assist nursery workers and supervisors to appreciate their daily work while raising tree seedlings.

The topics covered in the manual allow the user to see an open space developing from skeleton nursery to one where ready seedlings can be collected for planting in the field. Consequently the guidelines flow sequentially from siting a nursery to the preparation of a seedbed for sowing seed, the ingredients of the nursery soil and the way the soil should be put into containers or seedlings beds. Then follows how the young seedlings should be transferred to containers, the shading requirements and how the seedlings should be tended as they grow. The guidelines also look at the requirements for nursery records, the need to monitor diseases or harmful insects pests occurrences, and finally how to lift seedlings from the nursery to the field for planting.

1. SITING A TREE NURSERY:

A tree nursery should be located in an area with the following characteristics:

- Reliable water supply;
- Level or terraced ground;
- Easily accessible by vehicles;
- Free from frost;
- Sheltered from wind.

There are some areas where a nursery should not be located. These are valleys, hills and slopes as shown below.

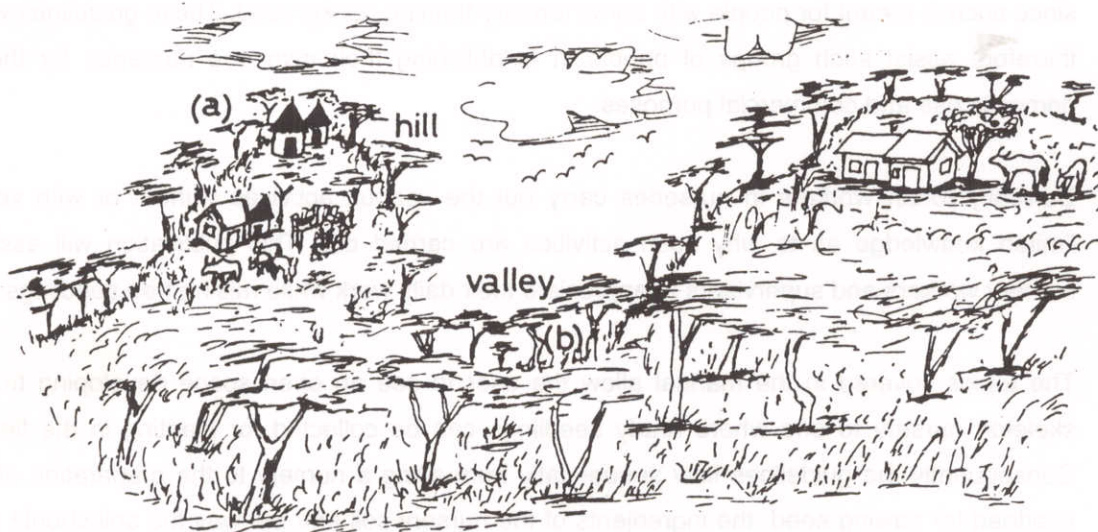


Figure 1: Places where a nursery should not be located.

At point (a), which is a hill top, vehicles cannot reach the nursery, especially during rainy season. Transporting the seedlings from point (a) to planting sites could therefore be difficult. Delivery of the various nursery materials also could be a problem.

Down the valley bottom at point (b), the area may be water logged or flooded during the rain season. Along the slope (point c), siting of a nursery may be a problem as rain water running down could destroy the nursery. However, a slope can be terraced in order to have level beds.

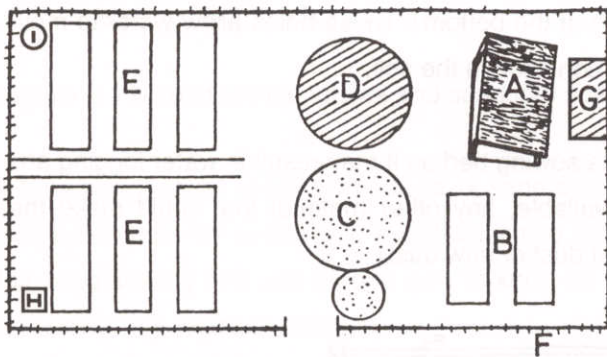
The most ideal site for a nursery is a level or gently sloping ground with trees on the leeward side to act as a windbreak.

The nursery should as much as possible be surrounded with a live fence (hedge). The fence helps to reduce water loss from seedlings by acting as a wind break.

To produce 200,000 bare rooted seedlings, a 100 m long and 20 m wide nursery is necessary, while 100 m by 50 m will be necessary to raise 500,000 seedlings. When using containers, larger areas will be required.

A standard nursery should have a shed, seed sowing bed, soil storage area, soil mixing area, seedlings beds as shown in figure 2.

Figure 2: The requirements of a standard nursery.



- A = Shed
- B = Seed sowing beds
- C = Soil storage
- D = Soil mixing area
- E = Seed beds
- F = Live fence
- G = Store
- H = Pit latrine
- I = Water tank

There should also be a store for keeping working tools, equipments and other materials.

2. SEED SOWING BED

Seed sowing beds facilitate the sowing of the fine seeds of e.g. *eucalyptus* and *casuarina* species, that can not individually be sown into separate tubes. However, large seeds can be sown directly into tubes or containers. Containers may also be used as seed sowing beds.

The sides of a seed bed should be 15 cm (6 inches) high above the ground with the bottom five cm made up of broken stones, the next 2.5 cm filled with gravel layer and the top 7.5 cm with river sand. Sawn timber or logs of at least 17 cm diameter are laid parallel on the ground one metre apart. At both ends, similar timber or logs are placed so as to make a seeds sowing bed of the desired length. Wooden pegs are used on the outside to hold the timber or logs in place, while the stones, gravel and sand hold them from the inside (Fig.3).

The seedlings attain the pricking out height to be transferred from the seeds sowing bed to the seedlings bed or container by obtaining food from the seed itself and water. It is therefore not necessary to supply plant nutrients in the seed bed. For raising a few seedlings, one can use a tin with holes at the bottom. These holes allow water to move out of tin without causing excessive water condition in the soil.

It is not advisable to use soil in a seeds sowing bed as it may result in water logging and this kills the seedlings. If sand is not available, any other material that could make the soil porous may be used including charcoal dust or saw dust.

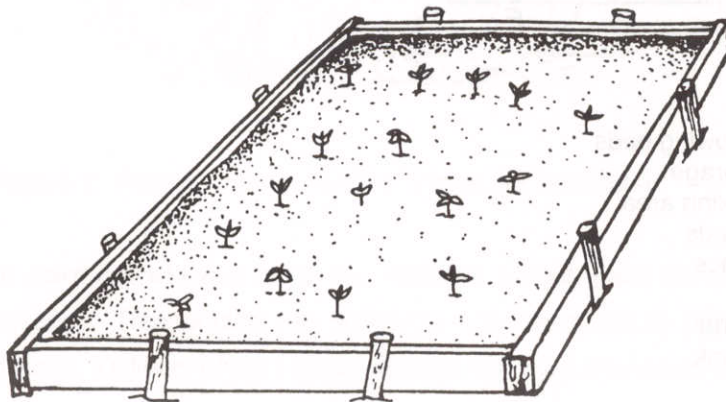


Figure 3: Seed sowing bed with germinated seedlings

The sand should not be filled to the top of the bed or container. A space of 2 to 3 cm should be left at the top (Fig 4).

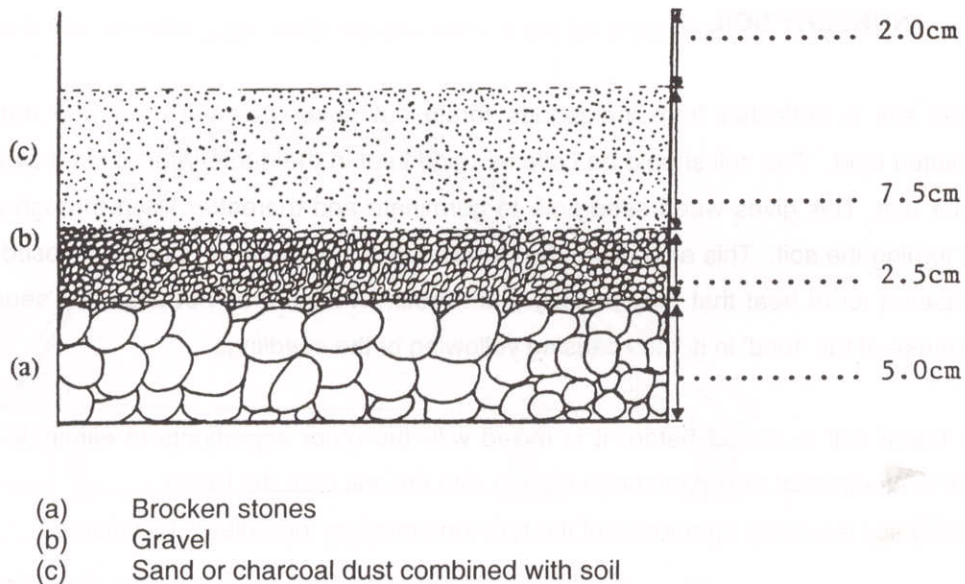


Figure 4: Filling of stones, gravel and sand into seed sowing beds or containers

After sowing, cover seeds with a layer of sand twice their size and ensure no seed is visible. Use a fine rose for watering to avoid splashing the sand and the seed. After sowing cover the seed sowing bed with mouse wire to keep off the mice and birds. Inspect the bed daily and cover any exposed seed.

Various seeds take different duration in soil before germination starts. For example *Casuarina equisetifolia* at Gede take one week, while the same species takes two to three weeks to germinate at Muguga. Other species such as *Pinus canariensis*, *Sesbania sesban*, *Dovyalis caffra* and *Eucalyptus filicifolia* take two weeks to germinate at Muguga. *Acacia melanoxylon* takes three weeks, while both *Pinus patula* and *Eucalyptus saligna* take four weeks. *Cupressus lusitanica* at takes six weeks to germinate at Muguga.

Other species will always have irregular germination unless some pretreatments are carried out. For example experiences over a number of years in Nyandarua have shown that germination of four species can be highly improved by soaking them in water for different durations. *Vitex keniensis* should be sown after soaking the seeds in water for 21 days; *Juniperus procera*, sown after soaking for 14 days; *Podocarpus* species, soak for 18 days and then sow; while *Condia abyssinica* requires 16 days to give uniform germination after

sowing. The bottle brush (*Callistemon species*), a popular ornamental species experience high mortality after germination. This can be reduced drastically by minimising the amount of water applied.

3. NURSERY SOIL

Forest soil is collected from indigenous forest but never below 15 cm and not from a cultivated land. The soil should be collected and kept in the nursery for at least two months before use. This gives weed seed time to germinate and thereafter killed through watering and turning the soil. This also allows for decomposition of manure. Undecomposed manure releases a lot of heat that may destroy plant roots. It also does not allow the seedlings to make use of the 'food' in it, thus causing yellowing of the seedlings.

The forest soil is sieved before it is mixed with the other ingredients to eliminate parts of trees or stones that may have been carried with the soil from the forest.

Nursery soil is usually composed of the following medium ingredients by volume:

- Forest soil 5 parts.
- Rotted compost manure eg cow dung manure 1 part.
- Crushed stones 1 part
- Clay crushed to 0.5 cm particles 1 part.
- Pine soil (when raising pine seedlings) 1 part.

To every cubic metre of the soil mixture, two kgs of nitrogen, phosphorous and potassium (NPK) fertilizer are added. When raising pine or casuarina seedlings, soil obtained from under these trees is also added. This soil contains some micro organisms required by either pine or casuarina seedlings for their development. The ingredients must be thoroughly mixed before use.

a) Seedling Bed

The soil is either put into prepared seedling beds (swaziland beds), polyethylene tubes, or other locally available containers such as milk packets and tins. These containers should be perforated to allow the water to flow downwards freely and therefore ensures the soil has also some air necessary for root development.

These beds are 18 cm high from the ground and one metre wide (Fig 5). The length will depend on the required number of seedlings and the size of the nursery area. Like the seed sowing bed, the seedling bed is constructed using logs or planks of timber of at least 18 cm in width and of the desired length. On the outside of the bed, the planks of timber are supported by wooden pegs while the soil holds them on the inside (Fig 5).

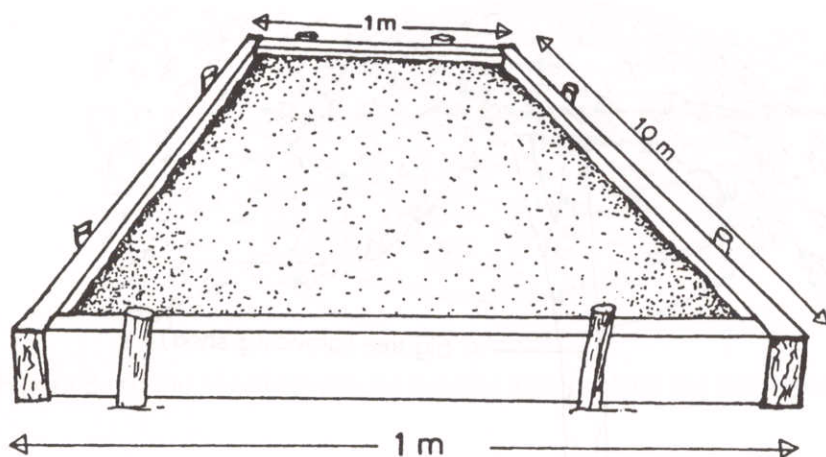


Figure 5: A Seedling (swaziland) bed ready for planting of seedlings

b) Polyethylene tubes

The commonly used polyethylene tubes are 10 cm wide and 15 cm long when laid flat. For slow growing species like most of indigenous species, large tubes should be used. If small ones are used, these need to be changed during their development. However for seedlings that may take a long period in the nursery, large containers which are perforated may also be used.

Other containers that are used for raising seedlings include those shown in figure 6. As with polyethylene bags, these containers should also be perforated.

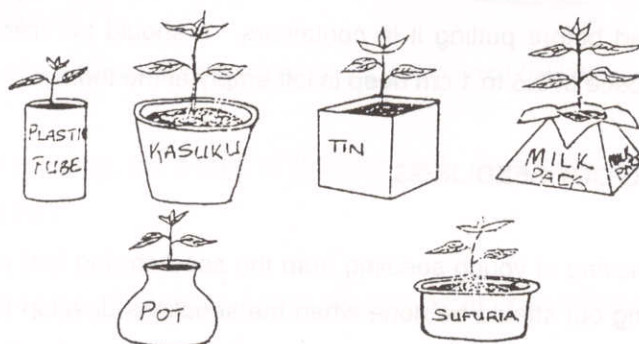


Figure 6: Alternative seedling containers.

4. POTTING

There should be a working shed for soil potting and pricking out in a nursery. However in a small nursery, a tree shade will serve the purpose of providing shade (Figure 7).

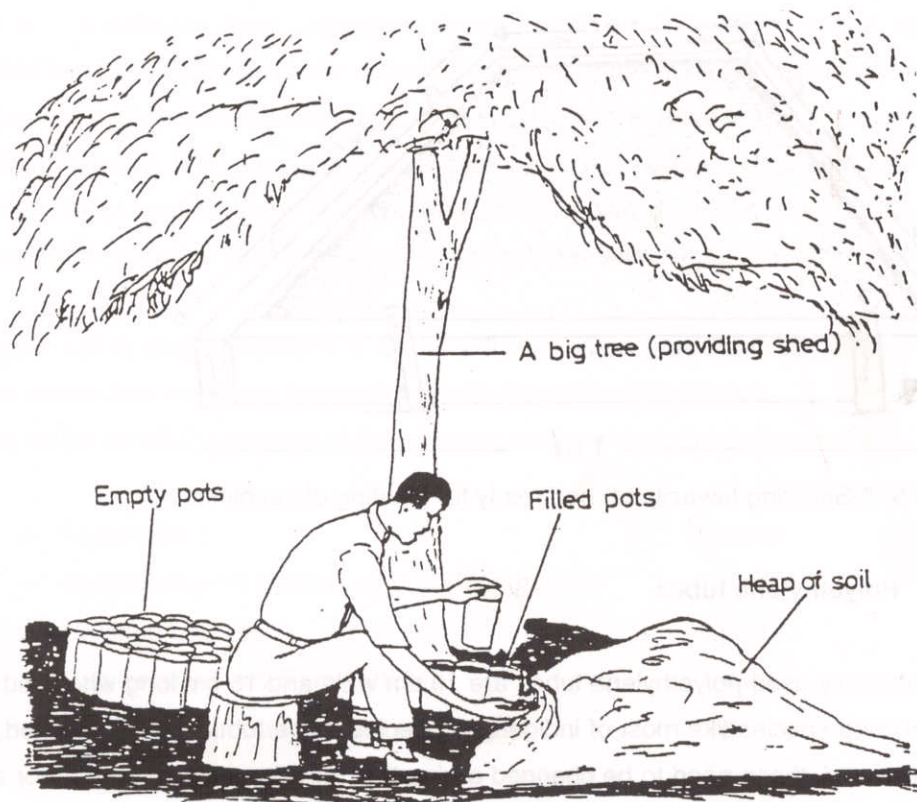


Figure 7: Potting containers under a tree.

The soil is watered before putting it in containers. It should be filled to the top and then firmed so that a space of 0.5 to 1 cm deep is left empty at the top.

5. PRICKING OUT SEEDLINGS

This refers to removing of young seedling from the seed sowing bed and planting them in a container. Pricking out should be done when the seedlings develop their first leaves and a tiny rosette in the centre. It is necessary to water the seed sowing bed before pricking out the seedlings. This makes the soil around their roots loose and makes it easy to remove

the seedlings from the bed. It also ensures no damage occurs on leaves during the removal of the seedlings. The seedlings should be dug out with a planting dippler and immediately place in a container with water, as the young seedling roots should not be exposed to dry wind or direct sunlight, otherwise they will dry up (Fig.8).

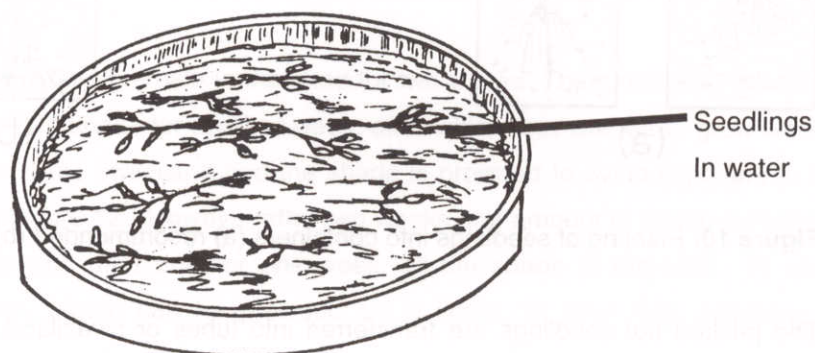


Figure 8: Young seedlings placed in water after pricking out and before transplanting

The seedlings are handled by their cotyledon leaves but not the tender stem (Fig.9). This is because it is easy to crush the stem and damage it creating entrance of harmful fungi or cause death of seedlings.

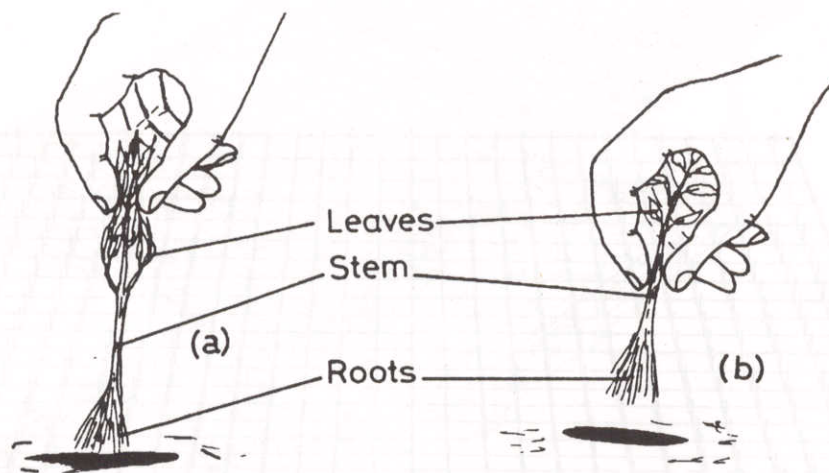


Figure 9: Handling of seedlings during pricking out: (a) correct (b) wrong

Before planting the seedling, cut a third of the long root. During the actual planting do not bury the stem in the soil.

However slight deepening of the stem below the root collar does not interfere with seedling development (Fig 10).

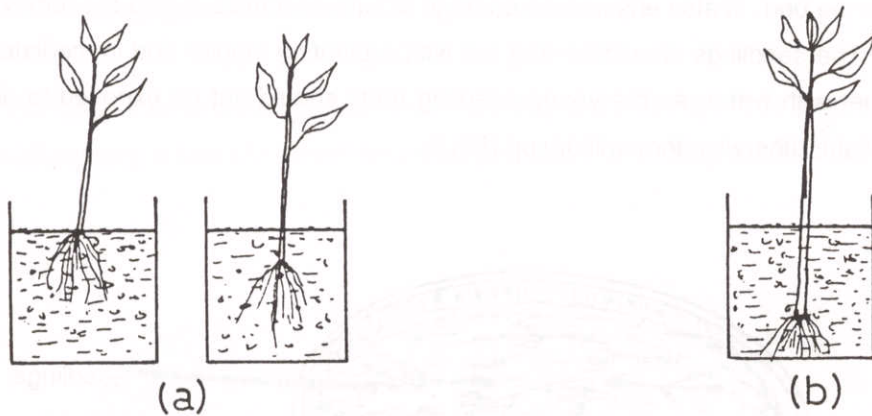


Figure 10: Planting of seedlings into containers (a) recommended (b) not recommended

The pricked out seedlings are transferred into tubes or swaziland beds. Seedlings in the swaziland bed should be planted in a regular pattern to provide easy access during weeding and root pruning. For most fast growing species like cypress and pine, seedlings are planted at a spacing of 7.5 cm by 5 cm. In large nurseries, a two metre by one metre marking board with nails spaced at 7.5 cm by 5 cm sticking out is used to mark the planting spots on the seedling bed (Fig 11).

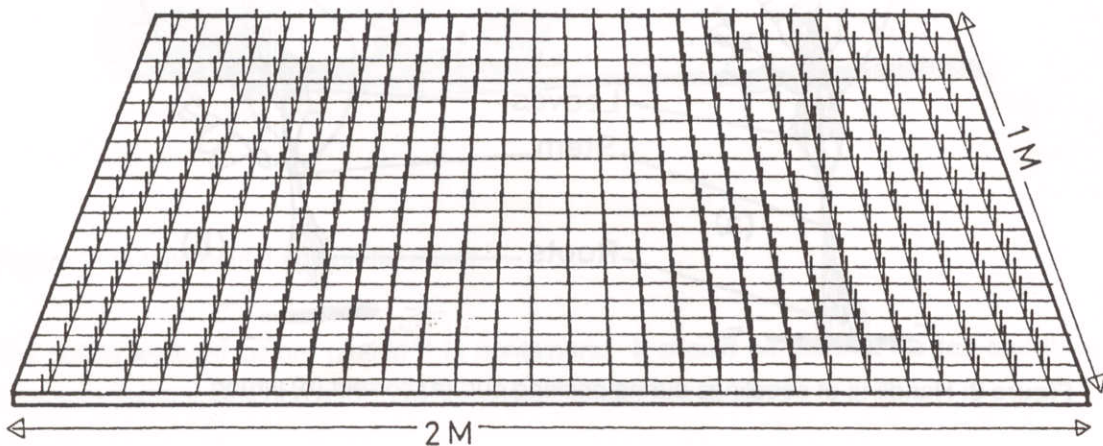


Fig. 11: A marking board with nails placed at 7.5 cm by 5 cm

6. SHADING

Pricking out of seedlings should be done in shade because the young seedling roots are disturbed and any prolonged exposure to evaporation agent e.g. dry wind or sun will cause death. The seedlings need to retain as much water as possible during this time before the hair roots develop to a stage where they can absorb water and nutrients from the soil.

Seedlings in containers should remain in the shed for two weeks. Thereafter they are taken out and placed under light shade for another week, after which they are left to grow without shade. For seedlings in the swaziland bed the shade is provided to avoid exposure to the direct sun shine as in Figure 12. However after two weeks, the amount of shade is reduced by reducing the cover and after another one week, all the shade is removed. In small nurseries without shed, shade can be provided as in figure 12 even with seedlings in containers.

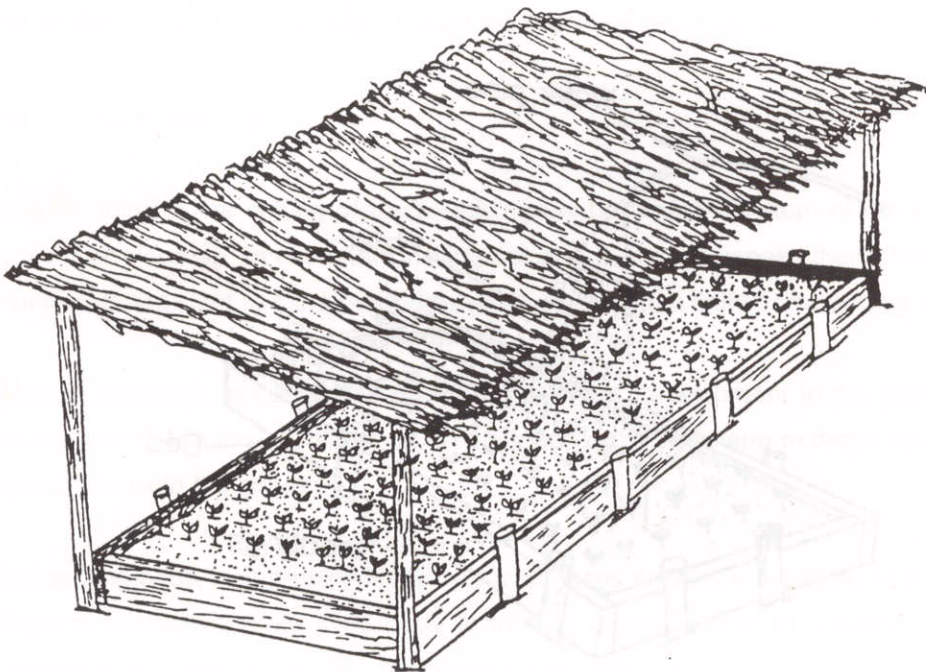


Figure 12: Shading pricked out seedlings.

7. TENDING OF SEEDLINGS

There are four important operations that are essential for raising healthy seedlings. These are :

- a) Water;
- b) Weeding;
- c) Root pruning; and
- d) Cultivation.

a) Watering

Seedlings, like other living things require water for their life. In water, the nutrients that seedlings depend on are dissolved and are taken up by the plants through the hair roots. Watering is done twice a day, in the morning and in the evening for seedlings exposed to sunshine. Seedlings in the shade can be watered once a day. During the rainy season, watering is not necessary.

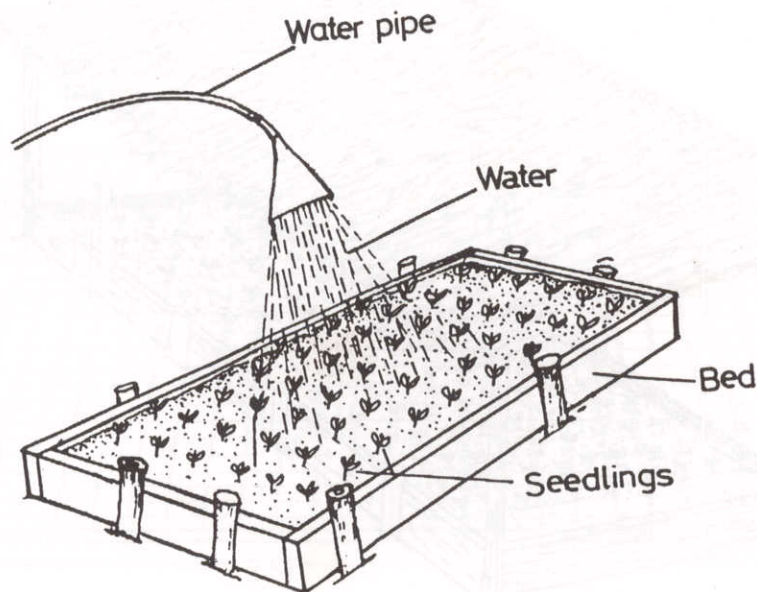


Fig.13: Watering young seedlings in a Swaziland bed

The temperature of the water used is an important factor that must be considered. Water obtained directly from a river is normally more cold than stored water. Therefore as much as possible, seedlings should be watered using stored water, rather than from rivers. On the other hand, in the afternoon, water trapped in the pipes get very hot and normally does not cool quickly. therefore during the evening water, such water should be poured until cold water from the tank comes out. Accidental use of such water may result in excessive mortality.

b) Weeding and Cultivation

Weeding means removing any other growing vegetation except the required seedlings. Weeding is necessary to remove competition of seedlings with those other growing vegetation for soil nutrients and water. Weeding can be done whenever necessary.

Cultivation of top soil in a bed loosens the soil which enhances the movement of water and allows air circulation in the soil. When no cultivation is done, the top layer of soil forms a hard crust which later turns green. This hinders free movement of water to the roots as well as air circulation in the soil. As a result, the seedlings grow poorly.

c) Root pruning

Root pruning is the cutting of roots which grow beyond the bottom of the tubes or beds. It should be done six weeks after pricking out and every four weeks thereafter. Seedlings in containers are lifted and the protruding roots cut off with a knife or panga (fig 14 a).

Moving seedlings in containers often prevents root development in the ground and saves pruning time. Placing seedlings on hard surface or polyethylene material also prevents root penetration into the ground.

In seedling beds, root pruning involves 3 main steps as shown in Figure 14 b) The first step involves running a sharp knife deep in the soil between rows of seedlings parallel to the seedling bed. After two weeks, the same is repeated but across the seedling bed. The third step involves cutting the roots growing deep into the soil and requires two people with a wire. The wire is placed below the log or plank of wood at one end of the bed. Through sawing, the wire is pulled from one end of the bed to the other while cutting the roots deeper than the width of the log. It is important to prune seedlings at least a week or two before field planting.

When frequently done as recommended, pruning facilitates the development of a more fibrous root system of the seedling (fig 15). This hardens them for the harsh conditions in the field where attention and care is less than in the nursery.

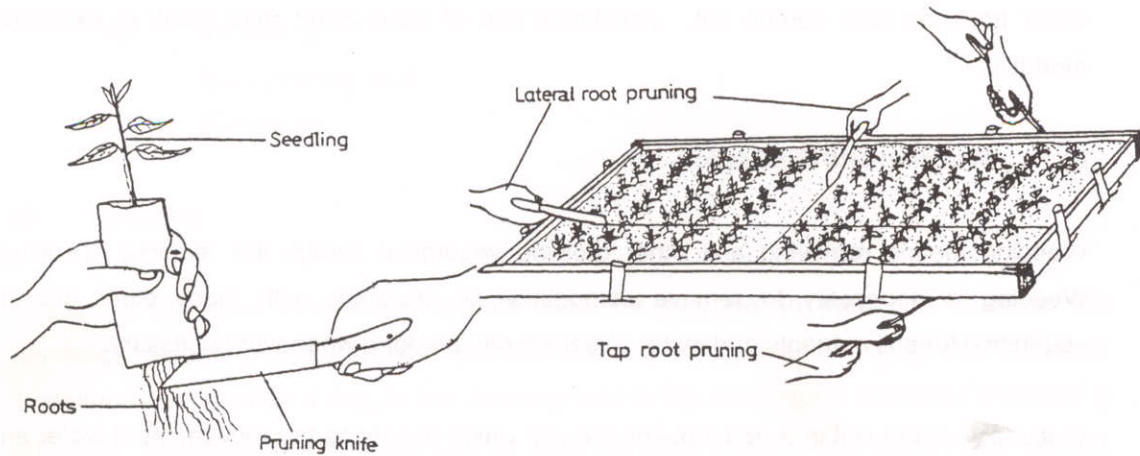


Figure 14: Root pruning to promote development of fibrous roots

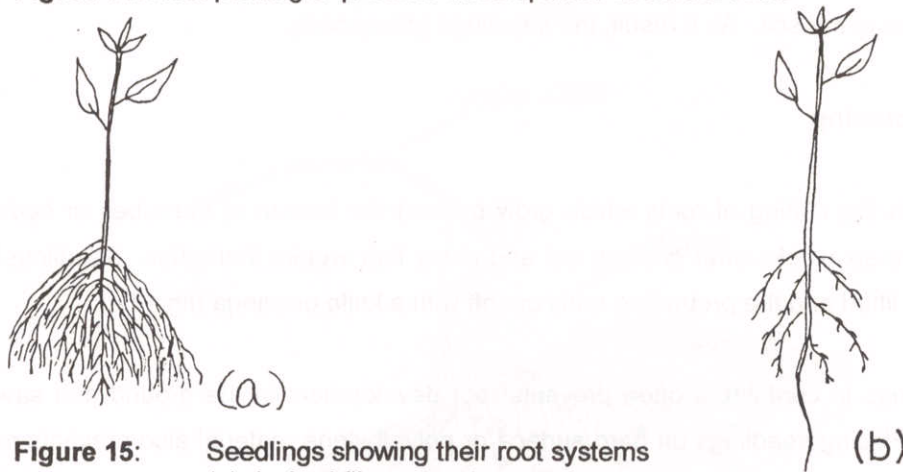


Figure 15: Seedlings showing their root systems
(a) desired fibrous root
(b) long tap root with few fibrous roots

The use of large pebbles and stones at the bottom of the bed can interfere with both horizontal and lateral root pruning. It is therefore necessary to place a layer of soil at the bottom before putting the pebbles to facilitate horizontal pruning using the wire.

8. NURSERY RECORD KEEPING

a) Nursery Diary Book

The nursery diary book is used for recording daily activities. These include:

1. Movement of seedlings -
 - i) number pricked out;
 - ii) number of dead seedlings; etc;
 - iii) how many seedlings were sold;
 - iv) free issue;
2. Application of fertiliser/manure
 - i) type of fertiliser/source of manure;
 - ii) date applied; and
 - iii) amount applied

b) Nursery record book

- i) seed source;
- ii) available nursery tools and equipments in stores;
- iii) disease outbreak and pest attack;
- iv) amount of seed sown by species;
- v) germination rate of different species;
- vi) number of seedling produced; etc

9. DISEASES AND INSECT PESTS ATTACK

The nursery heads or caretakers are expected to report outbreak of diseases and insect attack noticed on the seedlings. Private farmers should make such reports to the forest extension officers in their areas for advice on action required.

10. PLANTING NURSERY SEEDLINGS IN THE FIELD

Only healthy seedlings with high chance of survival should be removed from the nursery for planting in the field. These are seedlings that are of the right size (30 cm to 50 cm) that have been growing vigorously. They should also have been conditioned to the field condition through hardening (reduction of water applied and undertaking root pruning). The seedlings should be

removed from the nursery with minimum disturbance to the soil holding onto the roots. As much of this soil as possible should be retained up to the planting spot especially with seedlings raised in seedling beds. With containerized seedlings, the container should be removed just before planting and the ball of soil loosened to allow free movement of both air and water around the roots.

If the nursery is far from the planting site and seedlings have to be transported by trucks or trailer, they should never be loaded on top of each other to avoid breakages. Loading should be done with maximum care for seedlings from beds to preserve the soil. Unloading should likewise be done with maximum care and seedlings should never be tipped over either from a truck or even a wheel barrow. Transporting of seedlings is recommended early in the morning or in the evening when the evapotranspiration rate is low. This means seedlings suffer less shock as compared to when transportation is effected mid-day. In situation where seedlings cannot be planted immediately, they should be stored temporarily under a shade e.g. under a big tree or on farm under other crops like beans to protect them from excessive evaporation. It is necessary to ensure that land preparations in the planting area are complete before transporting seedlings to the field for planting. Make sure you only transport enough seedlings for the available labour to the planting site. As much as possible, seedlings should be planted the same day they leave the nursery.

It is important never to leave the roots exposed to the sun at any time. Cover them with wet sacks or wet soil to maintain the moisture around them.

For unforeseen reasons, it is possible that seedlings have been delivered to the field and planting has to delay. To successfully keep the seedlings in the field, three steps are necessary. First dig a trench, place the seedlings in the trench to the level of the tube or soil. Replace the soil into the trench and if possible water them.

Secondly, this should as much as possible be done under some tree shade and for potted seedlings, replace the fallen off soil before placing in the trench.

Transplanting in the field should be carried out early in the rains after adequate soil mixture build up. Remember to remove the container (e.g. polythene tubes) before planting.

GLOSSARY

Absorb: The process through which plants take water and other necessary elements for its growth from the soil into its roots.

Bare rooted seedlings: Seedlings with roots covered by soil that is not held by any container.

Conditioning: Treatment given to seedlings in a nursery to make them sturdier and better able to survive planting out (see hardening off).

Container: A receptacle in which seedlings are grown and taken to planting out in, so that a ball of soil remains attached to the roots.

Dibbling: Make a hole in which to plant a young seedling in a container or seedling bed.

Decomposition: The process of rotting

Dissolved: The process of change from a solid to liquid e.g. sugar or salt dissolve in water.

Fine rose: A water outlet from a hose pipe or watering can that has very small holes.

Fungi: Very small organisms that usually affect the growth of plants.

Germination: The process of seed development in which the seed produces roots and shoots.

Hardening off: A method of toughening seedling while still in the nursery to prepare them for the shock of normal field conditions. If gradually given less water and exposed to more direct sunlight, the seedlings are more likely to survive after transplanting.

Leeward side: The direction from which the wind is blowing.

Lifting: The nursery operation of removing seedlings from a seedling bed in readiness for planting out.

Nutrients: Substance dissolved in soil water that the plant uses to grow.

Pests: Living organisms that cause weakening or disease among seedlings.

Pitting: Digging of a hole in the field for planting.

Porous soil: Soil that is not compact and has numerous tiny air spaces.

Pricking out: Transfer of tiny seedlings from the seed sowing bed where they germinated to a permanent growing medium in the nursery e.g. a filled container or seedling bed.

Root pruning: The process of regularly cutting back the roots of plants to encourage the development of dense, sturdy and well developed rooting system.

Terracing: cutting the ground so as to develop flat steps on which to place beds.

Transplanting: the removal of seedlings from a bed to the field.

Weeding: the removal of vegetation growing together with the desired ones.

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